

Physical Activity Mode and Survival in U.S. Adults

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Abstract Purpose: The purpose of this study was to examine the protective effects of different modes of physical activity (PA) on all-cause mortality in adults. **Methods:** Data for this research came from the 2001-2002 National Health and Nutrition Examination Survey (NHANES). Participants 18+ years of age who were eligible for mortality linkage were used in the analysis. Different modes of PA were determined from a series of questions asking respondents if they participated in transportation (TPA), home/yard (HPA), moderate recreational (MPA), vigorous recreational (VPA), or muscle strengthening (MSPA) physical activity. Those respondents answering “yes” to either question were considered participating in that PA mode. Cox proportional hazards regression was used to model the effects of PA mode on mortality while controlling for age, sex, race, and income. **Results:** Adults were at less risk of mortality if they participated in TPA (Hazard Ratio (HR) =0.72, 95% CI: 0.57, 0.90), HPA (HR=0.43, 95% CI: 0.33-0.55), VPA (HR=0.30, 95% CI: 0.23-0.38), MPA (HR=0.53, 95% CI: 0.45-0.62), and MSPA (HR=0.44, 95% CI: 0.32-0.60). The adjusted model showed a 24.0% decrease in mortality (HR=0.76, 95% CI: 0.67-0.85) for each additional PA mode adopted. **Conclusions:** Results from this study indicate that various types of PA protect adults from all-cause mortality. Additionally, a dose-response relationship exists between the number of PA modes adopted and risk of mortality.

Keywords: applied statistics, epidemiology, mortality, Cox regression, physical activity

Cite This Article: Peter D. Hart, “Physical Activity Mode and Survival in U.S. Adults.” *American Journal of Applied Mathematics and Statistics*, vol. 5, no. 4 (2017): 154-158. doi: 10.12691/ajams-5-4-6.

1. Introduction

Physical activity (PA) is a preventive health behavior that protects against chronic disease as well as premature mortality [1]. Current U.S. guidelines on PA recommend that all adults accumulate at least 150 minutes each week of moderate-intensity PA or a combined moderate with vigorous-intensity equivalent [2]. Studies have shown that meeting recommended levels of PA is associated with positive health outcomes in adults [3]. Evidence also supports that meeting current PA guidelines is associated with mortality. One such study using a large cohort of Japanese adults showed that accumulating 150 minutes of PA was associated with lower risk of mortality [4]. This study additionally showed that both moderate and vigorous-intensity forms of PA contributed to the reduced mortality risk.

Another study that examined the relationship between PA and health used a sample of community-dwelling men 70+ years of age [5]. This study specifically examined the effect of walking speed on mortality and found that men with greater speeds saw less risk of both all-cause and cardiovascular mortality. A final study on Belgian men used both PA at work and in leisure-time combined with physical fitness as predictors of mortality [6]. Results from this study showed that low levels of both forms of PA increased risk of all-cause mortality. However, men

with low levels of leisure-time PA and high levels of work PA were still at greater risk of mortality, with even greater mortality risk if they were physically less fit.

Despite our knowledge regarding the protective effect of PA on various health outcomes, less is known about the various modes of PA and longevity in large-scale populations. Therefore, the purpose of this study was to examine the protective effects of different modes of PA on all-cause mortality in adults.

2. Methods

2.1. Participants and Design

Data for this research came from the 2001-02 National Health and Nutrition Examination Survey (NHANES) and associated mortality file [6]. NHANES is comprised of a series of continuous surveys designed to assess health and nutrition behavior and status in U.S. children and adults. Continuous NHANES data are organized into categories: demographics, dietary, examination, laboratory, questionnaire, and limited access data. NHANES provides a rich source of health data due to the physical examination and clinical laboratory data components. Mortality data were linked to NHANES participants by the National Center for Health Statistics (NCHS) and the most recent mortality status follow-up ended December 31, 2011. A total of 5,985 participants who were 18+ years of age, answered all PA

questions, and who were eligible for mortality linkage were used in the analysis.

2.2. Measures

Five different PA independent variables were used: transportation (TPA), home/yard (HPA), moderate recreational (MPA), vigorous recreational (VPA), and muscle strengthening (MSPA). PA mode status was determined from a series of questions asking respondents if they participated in TPA, HPA, MPA, VPA, and/or MSPA [7]. HPA was assessed by the following question: “Over the past 30 days, did you do any tasks in or around your home or yard for at least 10 minutes that required moderate or greater physical effort? By moderate physical effort I mean, tasks that caused light sweating or a slight to moderate increase in your heart rate or breathing. [Such as raking leaves, mowing the lawn or heavy cleaning.]” TPA was assessed by the following question: “Over the past 30 days, have you walked or bicycled as part of getting to and from work, or school, or to do errands?” MPA was assessed by the following question “Over the past 30 days, did you do moderate activities for at least 10 minutes that cause only light sweating or a slight to moderate increase in breathing or heart rate? Some examples are brisk walking, bicycling for pleasure, golf, and dancing.” VPA was assessed by the following question “Over the past 30 days, did you do any vigorous activities for at least 10 minutes that caused heavy sweating, or large increases in breathing or heart rate? Some examples are running, lap swimming, aerobics classes or fast bicycling.” Finally, MSPA was assessed by the following question: “Over the past 30 days, did you do any physical activities specifically designed to strengthen

your muscles such as lifting weights, push-ups or sit-ups?” Those respondents answering “yes” to either question were considered participating in that PA mode. Covariates were used to describe the sample and for controlling confounding in the statistical models. These covariates included sex (male/female), age (yr), race/ethnicity (White/Black/Mexican/Other), and income (U.S. \$).

2.3. Statistical Analysis

Prevalence estimates with their 95% confidence intervals (CIs) were computed for PA modes, overall and across demographic variables. Estimates were also computed across survival status and differences in prevalence tested using the chi-square statistic. Cox proportional hazards regression was used to model the effects of PA mode on mortality while controlling for age, sex, race, and income. SAS version 9.4 was used to account for the sampling design [8-11]. All significance levels were set to $p=.05$.

3. Results

A total of 5,985 adults were included in this analysis with a mean (median) person-year follow-up of 9.24 (9.83) and 965 deaths. Table 1 displays prevalence estimates of PA by mode across relevant demographic characteristics. Weighted prevalence estimates for TPA, HPA, VPA, MPA, and MSPA in 2001-02 were 24.1% (SE=1.7), 64.0% (1.1), 38.4% (1.5), 52.1% (1.6), and 29.7% (1.7), respectively. The prevalence of both VPA and MSPA decreased proportionately with age ($p<.05$). Contrarily, the prevalence of HPA, VPA, MPA, and MSPA increased proportionately with income ($p<.05$).

Table 1. Baseline Physical Activity (PA) Prevalence by Mode and Across Demographic Categories, US Adults 2001-2002

Characteristic	TPA		HPA		VPA		MPA		MSPA	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Overall	24.1	20.4-27.7	64.0	61.7-66.3	38.4	35.1-41.6	52.1	48.6-55.5	29.7	26.2-33.3
Sex										
Male	25.1	21.0-29.1	69.6	66.9-72.3	45.0	41.9-48.1	52.7	49.3-56.1	33.6	29.0-38.2
Female	23.1	19.7-26.5	58.7	55.6-61.9	32.1	27.9-36.3	51.5	47.3-55.7	26.1	22.9-29.2
Age (yr)										
18-29	32.7	27.0-38.4	56.8	52.4-61.2	51.0	43.7-58.3	53.2	47.6-58.8	39.9	35.0-44.8
30-39	22.4	18.4-26.3	68.9	67.1-70.7	43.9	39.6-48.1	57.2	51.3-63.1	36.0	31.9-40.0
40-49	19.4	15.0-23.8	70.8	66.8-74.7	39.3	36.3-42.4	53.5	49.5-57.5	25.7	19.9-31.6
50-59	23.1	17.7-28.5	70.2	66.4-74.0	33.0	26.7-39.3	50.2	42.9-57.5	26.9	21.1-32.6
60-69	21.2	17.5-25.0	63.0	58.7-67.2	22.1	15.0-29.2	50.3	44.2-56.4	19.5	15.9-23.1
70+	21.1	17.6-24.7	47.2	43.1-51.2	15.3	13.0-17.7	39.7	36.1-43.3	14.2	10.6-17.9
Race/Ethnicity										
White	24.9	20.5-29.3	70.9	69.1-72.8	40.8	36.6-45.0	57.1	52.6-61.6	31.2	27.0-35.4
Black	23.0	19.9-26.0	46.1	39.5-52.7	31.0	27.9-34.2	36.9	31.7-42.1	29.4	24.4-34.4
Mexican	21.9	18.5-25.4	43.6	36.7-50.5	31.5	27.3-35.7	33.3	29.2-37.5	23.4	19.7-27.2
Other	20.9	15.3-26.6	50.0	42.9-57.1	34.7	27.1-42.4	47.5	42.5-52.4	24.4	19.3-29.6
Income (US \$)										
0-14,999	33.2	25.0-41.5	43.8	39.1-48.5	27.2	18.7-35.7	39.4	33.8-45.0	22.1	17.4-26.9
15-24,999	25.9	19.3-32.5	51.4	45.3-57.4	31.0	25.8-36.3	41.4	36.0-46.8	22.9	18.2-27.7
25-44,999	22.0	18.0-26.0	61.2	57.2-65.3	31.8	26.2-37.4	48.5	43.4-53.6	24.9	20.2-29.6
45-74,999	25.0	20.0-30.1	70.4	66.7-74.1	40.9	36.6-45.1	53.9	49.8-58.0	28.4	24.3-32.5
75,000+	21.3	16.7-26.0	75.5	72.3-78.8	49.7	46.1-53.2	66.1	60.3-71.9	41.0	35.5-46.5

Note. TPA is transportation PA. HPA is home/yard PA. VPA is vigorous PA. MPA is moderate PA. MSPA is muscle strengthening PA.

Table 2 displays prevalence estimates by mode and mortality status. Prevalence of PA across all modes were significantly ($p < .001$) different between those that died and those that survived through follow-up. Most noteworthy, the number (0 to 5) of different PA modes adopted by participants was indirectly ($p < .001$) related to mortality risk. That is, among those adopting zero PA modes, 23% (95% CI: 20.17-25.2) experienced mortality, whereas among those adopting all five PA modes, 4.0% (95% CI: 0.4-7.7) experienced mortality by follow-up.

Table 3 displays hazards associated with PA mode. Adults were at less risk of mortality if they participated in TPA (Hazard Ratio (HR) =0.72, 95% CI: 0.55, 0.90), HPA (HR=0.43, 95% CI: 0.33-0.55), VPA (HR=0.30, 95% CI: 0.23-0.38), MPA (HR=0.53, 95% CI: 0.45-0.62), and MSPA (HR=0.44, 95% CI: 0.32-0.60). TPA and MSPA lost significance in the adjusted models, however, both suggested ($p < .09$) predictive ability. In the unadjusted model, a 37.0% decrease in mortality (HR=0.63, 95% CI: 0.56-0.70) was seen for each additional PA mode adopted. The adjusted model showed a 24.0% decrease in mortality (HR=0.76, 95% CI: 0.67-0.85) for each additional PA mode adopted.

Table 2. Prevalence of Physical Activity (PA) by Mode and Mortality Status, US Adults 2001-2002

	Died		Survived		p
	%	95% CI	%	95% CI	
TPA					<.001
Yes	7.7	6.3-9.0	92.3	91.0-93.7	
No	10.1	9.2-11.0	89.9	89.0-90.8	
HPA					<.001
Yes	6.5	5.5-7.6	93.5	92.4-94.6	
No	15.5	13.4-17.5	84.5	82.5-86.6	
VPA					<.001
Yes	3.8	2.8-4.8	96.2	95.2-97.2	
No	12.6	11.5-13.7	87.4	86.3-88.5	
MPA					<.001
Yes	6.7	5.8-7.6	93.3	92.4-94.2	
No	12.7	11.6-13.8	87.3	86.2-88.4	
MSPA					<.001
Yes	5.2	3.7-6.8	94.8	93.2-96.3	
No	11.5	10.5-12.5	88.5	87.5-89.5	
# of PA Modes					<.001
0	23.0	20.7-25.2	77.0	74.8-79.3	
1	13.5	10.8-16.1	86.5	83.9-89.2	
2	7.7	6.5-8.9	92.3	91.1-93.5	
3	5.1	3.7-6.5	94.9	93.5-96.3	
4	3.2	1.5-5.0	96.8	95.0-98.5	
5	4.0	0.4-7.7	96.0	92.3-99.6	

Note. TPA is transportation PA. HPA is home/yard PA. VPA is vigorous PA. MPA is moderate PA. MSPA is muscle strengthening PA.

Table 3. Hazards Associated with Physical Activity (PA) Mode, US Adults 2001-2002

	Unadjusted			Adjusted		
	HR	95% CI	p	HR	95% CI	p
TPA			.006			.089
No	1.00	-		1.00	-	
Yes	0.72	0.55-0.90		0.78	0.58-1.05	
HPA			<.001			<.001
No	1.00	-		1.00	-	
Yes	0.43	0.33-0.55		0.53	0.43-0.64	
VPA			<.001			.001
No	1.00	-		1.00	-	
Yes	0.30	0.23-0.38		0.60	0.45-0.79	
MPA			<.001			.001
No	1.00	-		1.00	-	
Yes	0.53	0.45-0.62		0.72	0.61-0.85	
MSPA			<.001			.066
No	1.00	-		1.00	-	
Yes	0.44	0.32-0.60		0.75	0.55-1.02	
# of PA Modes	0.63	0.56-0.70	<.001	0.76	0.67-0.85	<.001

Note. TPA is transportation PA. HPA is home/yard PA. VPA is vigorous PA. MPA is moderate PA. MSPA is muscle strengthening PA. Unadjusted model show crude odds ratios (ORs). Adjusted models show ORs adjusted for age, sex, race/ethnicity, and income.

4. Discussion

The purpose of this study was to examine the protective effects of different modes of PA on all-cause mortality in adults. A secondary purpose was to determine the extent to which a relationship exists between the number of PA modes adopted and survival. The results clearly showed that adopting any and all PA modes protected adults from mortality, even after adjusting for all sociodemographic confounders. Additionally, a dose-response relationship was found between the number of PA modes adopted by adults and subsequent mortality risk. That is, adults adopting more PA modes appeared to be at less risk than their counterparts adopting fewer PA modes. The evidence supporting the effects of various PA modes on mortality is sparse. One study has reported similar findings using a large sample (over 7,000) of French adults and assessed participant walking, sports-related activity, gardening, housework, and do-it-yourself project activity [12]. Findings from this study showed a protective effect across many different modes, however, only sports-related activity and do-it-yourself project activity remained protective after fully adjusting the models.

Other studies have corroborated these findings in terms of their investigation of PA intensity and its relationship to mortality. One study pooled data from six different cohort studies to examine the effects of leisure-time PA on mortality [13]. Results from this study showed that light

activity (e.g., brisk walking) was associated with a gain of almost 2 years toward life expectancy, as compared to inactive counterparts. Additionally, higher levels of PA was associated with even greater gains in life expectancy, as compared to inactive counterparts. Another study used meta-analytical techniques and analyzed data from 22 studies to examine PA intensity and subsequent all-cause mortality [14]. Results from this study showed that 30 minutes per day on 5 days per week of moderate-intensity PA was associated with an almost 20% reduction in mortality, as compared with no activity. Due to the limited data supporting the findings from this current study, these results should be considered novel. More research should also be directed toward confirming these findings.

The strength of this study is its use of nationally representative sample data. Due to the complex nature of the NHANES sampling scheme, the results from this study can be generalized to all U.S. adults 18+ years of age. Therefore, our study has an advantage over similar studies that examine relationships between PA and mortality in specific subpopulations and are then limited to specific generalizations. Our study does, however, have limitations worth mentioning. The main limitation in this study is the use of self-reported PA to assess the adoption of various modes of PA. Participant recall of PA has several drawbacks, as compared to objective measurement methods (i.e., accelerometers, pedometers, etc.). The main drawback of self-reported PA is that participants tend to overestimate their PA amounts and intensity and often as a consequence are misclassified as meeting recommended PA guidelines [15,16,17,18,19]. Considering this limitation, some studies have shown moderate agreement between subjective and objective measurement methods of PA [20,21,22,23]. Furthermore, this study was not concerned with the assessment of participant PA amounts. In contrast, this study examined the simple case of participants acknowledging being active in various modes of PA. The two intensity-related questions used to assess MPA and VPA gave examples of respective activities and so were considered two different sets of PA modalities of varying degrees and less so considered for their ability to accurately measure PA intensity. Therefore, PA misclassification in this case would seem less severe as opposed to the scenario of assessing PA amounts and intensities. Even though, because of these limitations, the results of this study should be interpreted with caution.

5. Conclusions

Results from this study indicate that various types of PA protect adults from all-cause mortality. Additionally, a dose-response relationship exists between the number of PA modes adopted and risk of mortality. Public health efforts may benefit from the promotion of multiple different PA modes to ensure increased longevity in U.S. adults.

Acknowledgements

No financial assistance was used to assist with this project.

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